BC X 231

A Guide to COMMON INSECT PESTS & DISEASES IN SPRUCE SEED ORCHARDS in British Columbia

D.S. Ruth, G.E. Miller and Jack R. Sutherland

Environment Canada
Canadian Forestry Service
Environnement Canada
Service canadien des forêts

89-05990/

ISSN-0705-3274

TABLE OF CONTENTS

ABSTRACT/RESUME 3

ACKNOWLEDGEMENTS 3

INTRODUCTION 4

INSECT FEEDING PERIODS 5

KEY TO COMMON INSECTS AND DISEASES 6

INSECTS

- Spruce seedworm 8
- Spiral spruce-cone borer 9
- Spruce coneworm and fir coneworm 11
- Spruce seed midge 12
- Seed wasp 13
- Western conifer seed bug 14
- Spruce cone axis midge 14
- Spruce cone gall midge 15
- Cone resin midge 15
- Spruce gall aphids
  - Cooley spruce-gall aphid 17
  - *Pineus* spp. 17
- Spruce aphid 18
- White pine weevil 19
- Spruce bud miners
  - Spruce bud midge 21
  - Spruce tip miner 21
  - Bud moth 21
- Defoliators 23
- Occasional Insects and Allied Pests 24

PREVENTION AND CONTROL

- Cone and Seed Insects 25
- Aphids
  - Cooley spruce-gall aphid 25
  - Spruce aphid 25

DISEASES

- Inland spruce cone rust and Coastal spruce cone rust 26

GLOSSARY OF TERMS 27

REFERENCES 28

DEPARTMENT OF SUPPLY AND SERVICES

ABSTRACT

This guide covers the common insects that reduce cone and seed production in spruce (*Picea* spp.) seed orchards in British Columbia. Emphasis is on identification of the various development stages of insects and their damage. Sections are included on insect control and on Interior and Coastal spruce cone rusts and their control.

RESUME

Ce guide comprend les insectes communs qui réduisent la production des cônes et semences de l'épinette (*Picea* spp.) dans les pépinières en Colombie-Britannique. On insiste sur l'identification des divers stades du développement des insectes et de leurs dégâts. Des parties concernant le contrôle des insectes et la rouille des cônes à l'intérieur de la Colombie-Britannique sont aussi incluses.

ACKNOWLEDGEMENTS

The authors wish to thank the following people: Mr. D. Evans, Dr. G.W. Wallis, Dr. H.A. Moeck, Mr. A. MacEwan, and Mrs. D.P. Lowe of the Pacific Forest Research Centre (PFRC), and personnel of the B.C. Ministry of Forests (BCMF) for reviewing the manuscript; Mr. J. Wiens, PFRC, for organization and layout; Mrs. E. Pass, PFRC, for preparing insect specimens; Ms. C.M. Lawko, PFRC, for preparing the French summary; and Miss M. Senecal, BCMF, for assistance with the illustrations. The authors are indebted to the following people for providing some of the illustrations: Dr. H.F. Cerezke, CFS, Edmonton, Fig. 8; Dr. T. vander Saar, Vancouver, Fig. 33; Mr. R. Duncan, PFRC, Figs. 41, 44b, 44c, 44d, 44e, and 44f; Dr. L.H. McMullen, PFRC, Figs. 34 and 35; Mr. E.J. Chatelle, PFRC, Fig. 27; Mr. D.W. Taylor, PFRC, Fig. 19; and Forest Insect and Disease Survey, PFRC, Figs. 36, 37, 43a, 43b, and 44a. The remainder of the pictures were taken by the senior author.

Cover

1. Adult western conifer seedbug
2. Seedworm larva and damaged seed
3. Seedbug eggs and emerging nymph

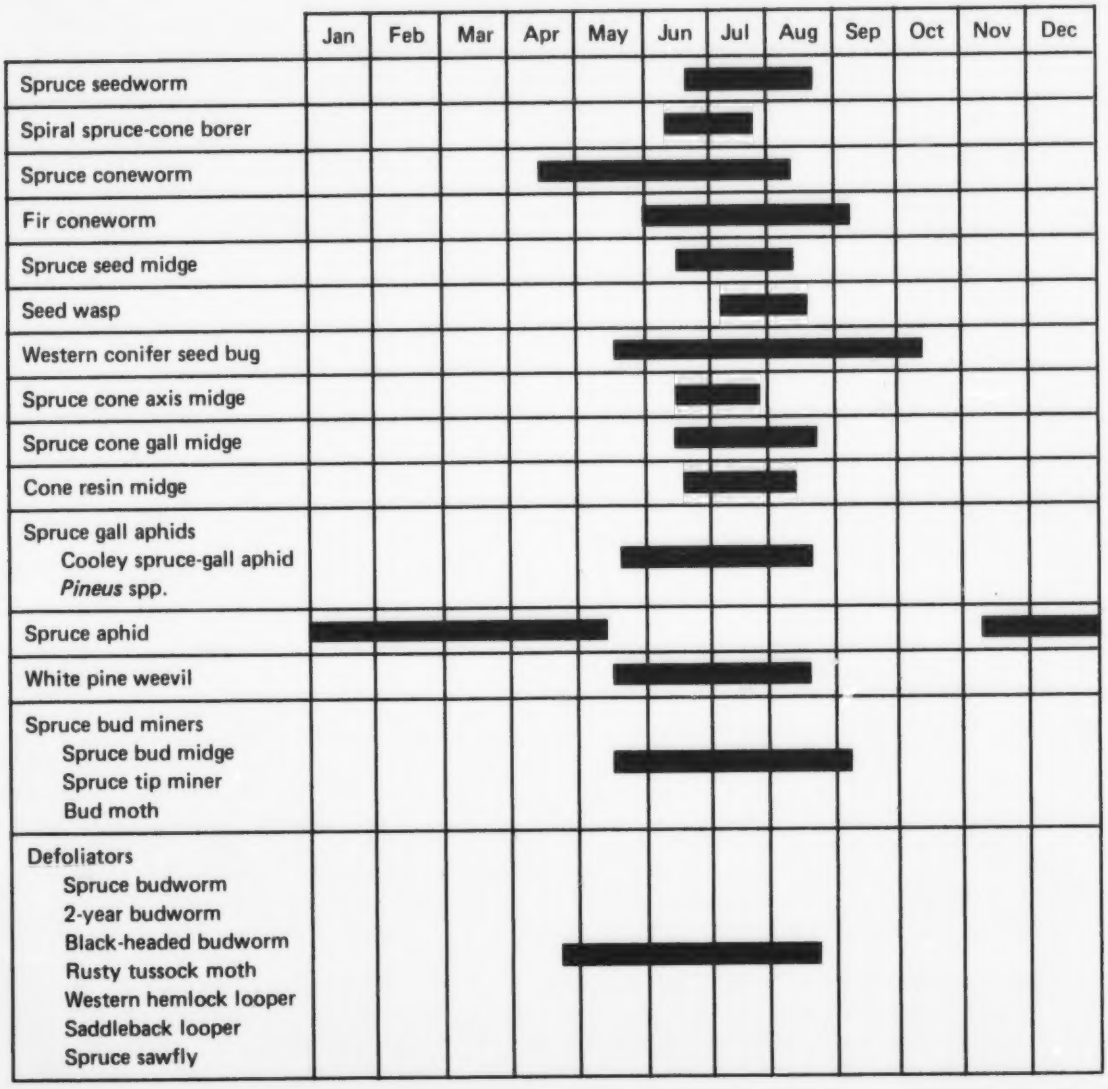
INTRODUCTION

Four native spruces occur in the forests of British Columbia: white spruce, *Picea glauca* (Moench) Voss; Engelmann spruce, *P. engelmannii* Parry; Sitka spruce, *P. sitchensis* (Bong.) Carr.; and black spruce, *P. mariana* (Mill.) B.S.P.

The demand for seeds—especially white spruce, Engelmann spruce, and Sitka spruce—is increasing to meet reforestation needs. More spruce seed is being sown in British Columbia forest nurseries than that of any other conifer. Spruce seed orchards have been established to produce better-quality seed; the value of this seed is considerably higher than that of seed from natural stands.

Cone and seed insects and cone rust often seriously affect seed production. Other insects can indirectly affect orchard seed production through effects on parts of trees other than cones. Other diseases (Foster and Wallis, 1969), such as root roots, may pose threats to orchard trees, but are beyond the scope of this bulletin. Information on insects and pathogens that attack seed orchard stock while these trees are in nurseries is available in Sutherland and Van Eerden (1980). It is important to recognize insects and pathogens that affect seed production in order to prevent or reduce losses to them. This bulletin was therefore prepared as an aid for seed orchard workers.

INSECT FEEDING PERIODS



Note:

Insects are in order of importance.

Because the insect populations vary from year to year, the insects' order of importance will also change.

The life history of the cone resin midge and bud moth are incomplete, therefore, larval feeding periods are only approximate.

KEY TO COMMON INSECTS AND DISEASES

1. (a) Insects present;
frass or pitch on cones or cones turning red or brown prematurely;
trees defoliated;
twigs or buds damaged 2

(b) Insects present or absent;
masses of yellow-orange spores present on
scales of prematurely opened cones . . . . . cone rust (p. 26)

2. (a) Insect or damage in cone 3

(b) Insect o damage not in cone 13

3. (a) Insect or damage in seed only;
other cone tissues not damaged 4

(b) Insect may or may not be in seed;
seeds or other cone tissues, e.g., scales, are damaged 6

4. (a) Insect in seed 5

(b) Insect not in seed;
endosperm shrivelled or incomplete
(may or may not be an insect problem) . . . . . western conifer seed bug (p. 14)

5. (a) Insect white with golden mouthparts;
body smooth . . . . . seed chalcid (p. 13)

(b) Insect yellow-orange maggot;
body obviously segmented . . . . . spruce seed midge (p. 12)

6. (a) Obvious feeding tunnels present in cones;
insects or frass may or may not be present 7

(b) No obvious tunnels;
frass not present;
insects on/in or damage to scales or axis 10

7. (a) Insect white maggot present in cones before end of July only;
feeding tunnel spirals around cone axis, may be filled with pitch;
no frass . . . . . spiral spruce-cone borer (p. 9)

(b) Insect caterpillars;
frass may or may not be present in seed or cone 8

8. (a) Frass in seeds or cones 9

(b) No frass in seeds or cones;
entrance/exit hole to cone surface or damage to cone surface . . . . . defoliators (p. 23)

9. (a) Fine frass in seeds;
caterpillar cream-colored with dark head;
located in axis after end of August, throughout cone prior to this. . . . . spruce seedworm (p. 8)

(b) Coarse, granular frass in cone;
red-brown (old) or amber (young) caterpillars present . . . . . coneworms (p. 11)

10. (a) Insects on or damage to scales 11

(b) Insects in or damage to axis 12

11. (a) Insect orange, segmented maggot, exposed between scales;
scale may or may not be necrotic . . . . . cone resin midge (p. 15)

(b) Insect small, orange, segmented maggot, not exposed but inside gall . . . . . spruce gall midge (p. 15)

12. (a) Insect large, cream-colored caterpillar;
in axis in August or later. . . . . spruce seedworm (p. 8)

(b) Insect small, yellow, segmented maggot;
may be in white cocoons . . . . . spruce axis midge (p. 14)

13. (a) Tree defoliated 14

(b) Tree not defoliated;
terminal, twigs or buds damaged 15

14. (a) Caterpillars present;
current growth damaged . . . . . defoliators (p. 23)

(b) Green aphids, the size of a pinhead or smaller, present on underside of needles;
current growth not attacked;
on coast only . . . . . spruce aphid (p. 18)

15. (a) Terminal damaged;
yellow-white, legless insect with light brown head
present in terminal . . . . . white pine weevil (p. 19)

(b) Cone-like galls on twigs;
aphids inside galls . . . . . gall aphids (p. 17)

(c) Buds damaged;
white caterpillar or orange-pink maggot present . . . . . bud miners (p. 21)

INSECTS

Fig. 1: Seedworm damaged seeds (left) and undamaged seeds (right)

Spruce Seedworm

Cydia (Laspeyresia) youngana (Kearfott)
(Lepidoptera: Olethreutidae)

Spruce seedworm, one of the two most important pests of spruce seed, attacks all native spruces. It is distributed throughout the range of spruces but is most common in the interior and northern coastal areas of the province. Severe infestations can completely destroy seed crops (**Fig. 1**); one larva in a cone can destroy 40% of the seed, three or more, 100%. Larvae mine through cones but feed only on seeds.

The adults, which emerge in late May or June, are smoky brown with silver bands across the wings and have wingspans of 8 to 11 mm (**Fig. 2**). Pale orange eggs, 0.5 mm in diameter (**Fig. 3**), are laid on the young conelet scales about the time of pollination. The eggs turn black just before hatching in mid- to late June, about 10 days after oviposition. Larvae (**Fig. 4**) complete their feeding by August or September, whereupon they tunnel into the cone axes to overwinter (**Fig. 5**). Large portions of the population may stay in diapause (overwintering stage) for a year or more if the next cone crop is poor. Pupation takes place in May, usually in the axis of the cone. The pupae are 4.3 to 6.3 mm long and tawny-colored, darkening to almost black just before emergence of adult.

Fig. 2: Seedworm adult

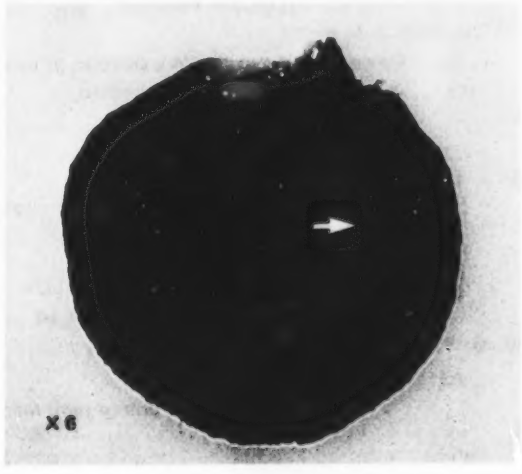


Fig. 3: Seedworm egg

Fig. 4: Seedworm larva and damaged seed

Fig. 5: Overwintering seedworm larvae

Spiral Spruce-Cone Borer

Hylemya anthracina (Czerny)
(Diptera: Anthomyiidae)

Spiral spruce-cone borer is the other major pest of spruce seed. It occurs throughout the ranges of spruces but is more common in the interior and northern coastal areas of the province. This insect can completely destroy seed crops; one larva in a cone can destroy 55% of the seed, two or more, 100%. The larva feeds indiscriminately on cone tissues, spiralling around the cone's axis (**Fig. 6**). When cone borers and seedworms attack the same cone, it is difficult to distinguish the damage done by each. The seedworm often leaves frass (granular material) in damaged seed, whereas the cone borer leaves clean tunnels, which often fill with pitch.

Adults (**Fig. 7**), similar in size and appearance to house flies, emerge in May and early June and deposit eggs singly between young conelet scales, about the time of pollination. The cigar-shaped eggs (**Fig. 8**), 1.5 to 1.8 mm long, are white and hatch in about

Fig. 6: Cone damaged by spruce-cone borer (arrow indicates feeding tunnel)

Fig. 7: Spiral spruce-cone borer adult

Fig. 8: Spiral spruce-cone borer egg

5 days. The maggots (**Fig. 9**), white with conspicuous black mouthparts, reach 8 mm in length when fully developed. Larvae finish feeding in July, at which time they leave the cones to pupate and overwinter in the ground. The pupae are red-brown (**Fig. 10**). The spiral spruce-cone borer, like the spruce seedworm and many other cone and seed insects, can remain in diapause for 1 or more years.

Fig. 9: Spiral spruce-cone borer maggot emerging from cone

Fig. 10: Spruce cone-borer puparia (overwintering stage)

Spruce Coneworm

Dioryctria reniculelloides Mutuura and Munroe
(Lepidoptera: Pyralidae)

and

Fir Coneworm

D. abietivorella (Grotè)
(Lepidoptera: Pyralidae)

Spruce and fir coneworms attack many conifers, including all spruces. Spruce coneworms attack cones and shoots and also feed on foliage, particularly in the absence of cones. Fir coneworms feed primarily on cones but occasionally attack twigs and graft unions. Coneworms are rarely abundant, but when so, they can completely destroy local seed crops, especially in years of light cone crop production. One larva (**Fig. 11**) is capable of heavily damaging a cone (**Fig. 12**). In seed orchards, where cone production is more consistent, the potential for populations to build up may be greater than in natural stands.

Spruce coneworms overwinter in hibernacula under bark scales and similar niches as young larvae. In the spring, they emerge and enter buds or male or female flowers; sometimes needles are mined first. Infested flowers and buds are enveloped in a mass of webbed frass. Fully developed larvae are about 17 mm long and are brown with five wide longitudinal stripes down their backs. Pupation occurs in cones or on foliage. Adults, mottled dark grey moths, with wingspans of about 24 mm (similar to Fig. 13), emerge in July and August. Females lay cream-colored, oval, 1 mm long eggs in bark crevices or similar niches on trees. The eggs hatch and the cinnamon-colored larvae spin hibernacula and overwinter.

Fir coneworm larvae occur in cones from June until September. Young larvae are amber-colored. The fully developed larvae, about 20 mm long, are amber to red-brown, with rows of brown spots down their backs. Pupae are amber to red-brown and about 10 mm long. Moths (**Fig. 13**) are mottled grey, with wingspans of about 28 mm. Eggs, laid on cone scales (**Fig. 14**), are pink, oval, and 1 mm long.

Fig. 11: Coneworm larva

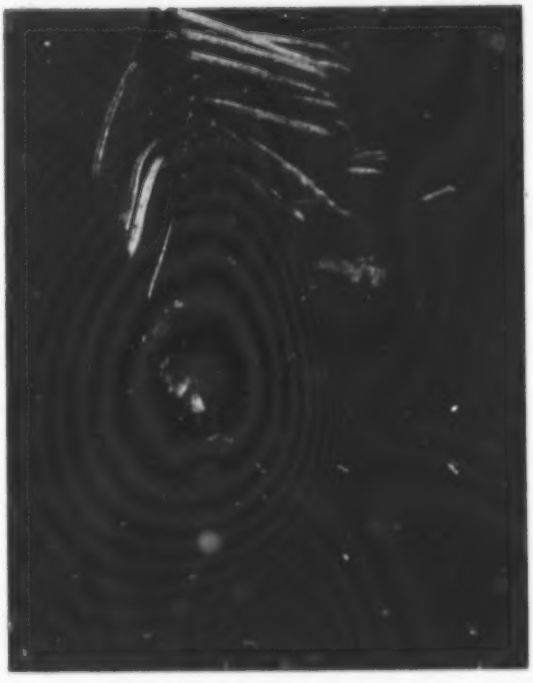


Fig. 12: Coneworm damage

Fig. 13: Fir coneworm adult

Fig. 14: Fir coneworm eggs on Douglas-fir cone bract (arrow indicates eggs)

Fig. 15: Seed midge larva

Spruce Seed Midge

Mayetiola carpophaga (Tripp)
(Diptera: Cecidomyiidae)

The spruce seed midge attacks white, and possibly other, spruces. Damage is usually not significant, although severe infestations may occur at some locations; up to 34% of the seeds have been infested at some sites.

The small (2.4 mm long) adult midges (similar to Fig. 24) emerge in late May or June, when females lay eggs near or inside the micropyles of the young ovules in conelets that are open to receive pollen. Eggs are visible only if ovules are dissected. Each larva develops in one seed. Feeding is completed by late July or early August. Fully developed larvae (**Fig. 15**), yellow-pink and 3 mm long, overwinter in the seed and pupate (**Fig. 16**) in May.

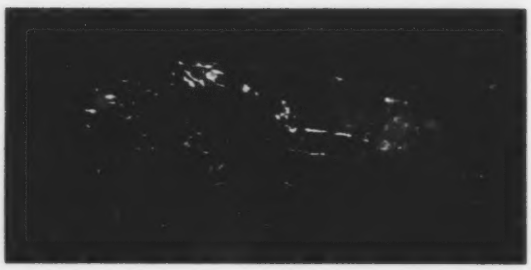


Fig. 16: Seed midge pupa

Fig. 17: Adult seed wasps: **(a)** female and **(b)** male

Seed Wasp

Megastigmus atedius Walker *(M. piceae* Rohwer)
(Hymenoptera; Torymidae)

Seed wasps attack white spruce and Engelmann spruce seeds throughout the range of these hosts; losses are usually minor.

The small (2.5 to 3 mm) wasps **(Fig. 17)** emerge in June and lay eggs in the seeds of conelets after they have been pendant for about 2 weeks. Females oviposit through cone scales and into developing seeds; incubation period of the eggs is about 2 weeks. Small, white, legless larvae **(Fig. 18)** feed within seeds for 6 to 8 weeks, devouring seed tissues, leaving only the seed coats. Each larva completes its development in one seed and only one larva can develop fully in a seed. There is no external evidence of damage on infested seeds and there is little difference in weight between infested seeds and healthy seeds, so infested seeds can be detected only by dissecting or X-raying the seeds **(Fig. 19)**. Larvae overwinter in seeds and pupate the following May. Pupation may be delayed 1 or more years if subsequent cone crops are poor. Exit holes in the seeds are evidence of adult emergence.

Fig. 18: Seed wasp larva

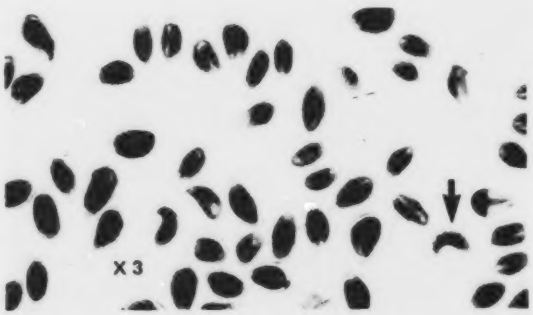


Fig. 19: X-ray showing filled, empty, and wasp-infested (indicated by arrow) seeds

Fig. 20: Adult western conifer seed bug

Fig. 21: Seed bug eggs and emerging nymph

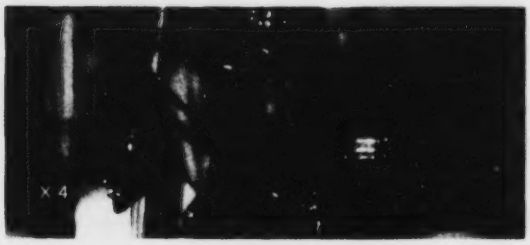


Fig. 22: Young seed bugs

Western Conifer Seed Bug

Leptoglossus occidentalis Heidemann
(Hemiptera: Coreidae)

Western conifer seed bugs attack cones of several conifers, including spruces. The amount of damage this sucking insect does is difficult to determine, but it can be considerable when occurring in large numbers. Seeds fed on before ovules are fertilized cannot be differentiated from seeds that abort due to other causes. Developing seeds that have been damaged after fertilization of the ovule have shrivelled endosperms. Damage can be detected only by dissecting or X-raying the seeds. The threat to spruce seed is difficult to assess, since the bug appears to feed on spruce only when it grows near other conifers.

Adults, which are red- to grey-brown (**Fig. 20**), become active in May or early June, but eggs are not laid until July or early August. Eggs, brown and barrel-shaped (**Fig. 21**), are laid in rows on foliage and hatch in about 2 weeks. Young bugs (**Fig. 22**) feed and develop on foliage for about 10 days before moving onto cones. The bug feeds by inserting its tube-like mouthparts through a cone scale and into a seed; feeding continues until the onset of cool weather or until the seeds drop from the cones. Most bugs have developed into adults by late September or early October and overwinter in sheltered places.

Spruce Cone Axis Midge

Dasineura rachiphaga Tripp
(Diptera: Cecidomyiidae)

The spruce cone axis midge attacks all native spruces, especially Engelmann and white spruces; it is the most abundant cone insect at some locations. However, it is not an important seed pest, as it feeds only on scale and axis tissues.

The adult, which emerges in late May or June, is dark brown and 2 to 3 mm long. Eggs are laid near ovules in open spruce conelets. The young larva mines into the scale near an ovule and turns toward the cone's axis, which it reaches in early July. When fully developed, the larva is yellow-orange and about 3 mm long. The larva spins a cocoon by late July and overwinters in the axis. It is not uncommon to find the entire axis filled with white cocoons of overwintering larvae (**Fig. 23**). Pupation occurs during early May and adults emerge in about 10 days.

Fig. 23: Fully developed axis midge larvae in cocoons

Fig. 24: Adult gall midge

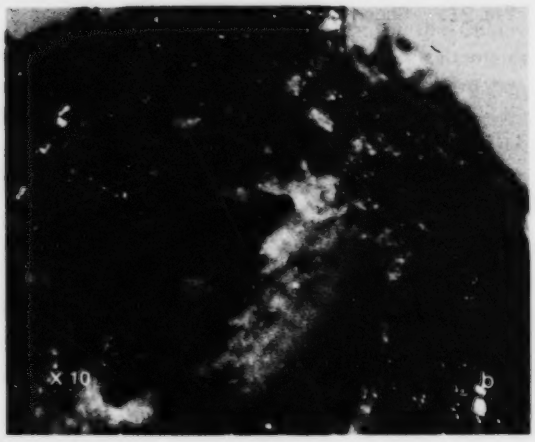


Fig. 25: (a) gall and (b) midge larvae

Spruce Cone Gall Midge

Dasineura canadensis Felt
(Diptera: Cecidomyiidae)

The spruce cone gall midge attacks white, and possibly other, spruces. It is plentiful in some areas but is unimportant as a seed destroyer.

The adults (**Fig. 24**) are small—about 2 mm long. They emerge in late May and June; the females lay white, oblong, 0.3 mm long eggs on the inner surfaces of the scales of open spruce conelets. After hatching, the young larva mines into the scale and forms a gall (**Fig. 25**); each gall is formed by a single larva. By mid- to late summer, when fully developed, the larva is yellow and 3 mm long. It overwinters in the gall and pupates in April or May. The pupa is 2.5 mm long and white in the early stages, later turning dark brown.

Cone Resin Midge

Resseliella sp.
(Diptera: Cecidomyiidae)

Little is known about cone resin midge. It attacks cones of many conifers but does not directly damage seeds. The orange larvae (**Fig. 26**) lie between the cone scales, sometimes under seeds, causing brown discoloration of the scale.

Fig. 26: Resin midge larvae and damage

Fig. 27: Sliced gall showing aphid chambers

Fig. 28: Cooley spruce-gall aphid galls: (a) new and (b) old

Fig. 29: Adult winged Cooley spruce-gall aphid

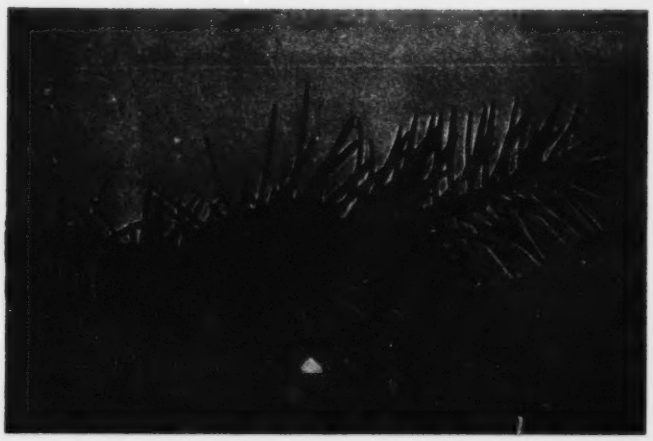


Fig. 30: Pine leaf chermid galls: (a) new and (b) old

Spruce Gall Aphids

(Homoptera: Phylloxeridae)

Spruces are attacked by three species of gall-forming aphids. These aphids, especially the Cooley spruce-gall aphid, can kill branch tips of seedlings and saplings and tend to stunt and deform trees. The effects of these aphids on seed production are not known.

Cooley Spruce-Gall Aphid

Adelges cooleyi (Gillette)

This aphid is a common pest of all spruces and Douglas-fir, *Pseudotsuga menziesii* (Mirb.) Franco, throughout the range of these trees but appears to reach its highest numbers where spruce and Douglas-fir grow together at low elevations. On spruce, cone-shaped galls up to 75 mm long are formed on tips of new growth by the swelling of infested stems and needles. Galls are separated into individual chambers (**Fig. 27**), each chamber containing up to 30 aphids. New galls, which are formed in June and July, are green and shaded pink or purple (**Fig. 28(a)**). Old galls, which may persist for several years, are brown, dry, and hard (**Fig. 28(b)**).

The life cycle of the Cooley spruce-gall aphid is complex, involving up to six adult forms and taking 2 years to complete. Aphids hatch in late May or early June and feed on new growth, resulting in gall formation. The nymphs feed in the galls for about 2 months. In late August or September, the galls dry and open and winged females disperse to lay eggs on Douglas-fir. The aphid must complete part of its life cycle on Douglas-fir to produce galls on spruce; forms of the aphid that do not cause galls live on spruce year round. Winged aphids (**Fig. 29**) migrate from Douglas-fir to oviposit on spruce in July and August. The females that hatch from these eggs overwinter on spruce and, in the following year, oviposit eggs that produce the gall-forming aphids. On spruce, eggs are oval, light brown, and about 0.5 mm long. Nymphs are yellow-brown to dark brown. The adults are red-brown to dark brown and are about 1 mm long. On Douglas-fir, the most noticeable signs of attack are white woolly aphids on the undersides of needles during the summer and discoloration and distortion of needles in heavy infestations.

Pineus spp.

Pine leaf chermid, *Pineus pinifoliae* (Fitch)

This aphid attacks Engelmann and Sitka spruce, as well as western white pine, *Pinus monticola* Dougl. On spruce, the aphid forms galls (**Fig. 30**) similar to those of the Cooley spruce-gall aphid, except that the feeding chambers are interconnected, each chamber contains one or two aphids, and the galls flare open at the time of adult emergence.

The life history is similar to that of the Cooley spruce-gall aphid, except that this aphid alternates between spruce and western white pine rather than between spruce and Douglas-fir. The adults (similar in appearance to Fig. 29) are hemispherical, 1.5 mm in diameter, brown, and have a fringe of white hairs. Nymphs are light to dark brown and range in size from 0.5 mm to over 1 mm in diameter.

Pineus similis (Gillette)

This aphid, which is rarer than the above species, attacks all native spruces, especially white spruce. Galls are initiated at the time of bud burst (May) and open in July. They differ from galls of the above aphids in that they are not divided into feeding chambers—the gall being the result of swelling, but not fusing, of the needles and twig.

The life history of this aphid is not well known. It is apparently less complicated than the foregoing aphids in that there does not appear to be alternation among different hosts and there are only four types of adults, similar in appearance to the pine leaf chermid. There are two generations each year. Overwintering nymphs hatch in late July and early August and feed for about a month before seeking shelter at the bases of the bud scales. Eggs are laid by the overwintering generation in May, these eggs giving rise to three types of aphids, two of which cause galls to form. Adults of the summer generation are fully developed by late July and lay eggs that give rise to the overwintering generation.

Fig. 31: Spruce trees defoliated by green spruce aphid

Spruce Aphid

Elatobium abietinum (Walker)
(Homoptera: Aphididae)

The spruce aphid occurs throughout the range of Sitka spruce. It feeds gregariously on spruces, sucking sap from needles 1 or more years old, causing defoliation and growth loss and, during severe outbreaks, tree mortality. Needle discoloration and needle drop (**Fig. 31**) vary with attack density and weather conditions. Effects of the aphid on cone production are not known. Spruce aphid is inconspicuous because of its small size, green color, and its occurrence on the underside of the needles.

The biology and natural control of the spruce aphid have been studied in detail in Europe, but not in North America. The insect feeds from late November to May or early June. Populations decline sharply during summer as temperatures increase. The aphid has two principal stages—nymph and adult (**Fig. 32**). Adults are 1.0 to 1.5 mm long, olive green, and predominantly wingless females. Nymphs (which are born directly) are green, oval, and 0.5 to 1.4 mm long.

Fig. 32: Adults and nymphs of green spruce aphid

Fig. 33: White pine weevil adult

Fig. 34: Egg puncture covered with black substance (indicated by arrow)

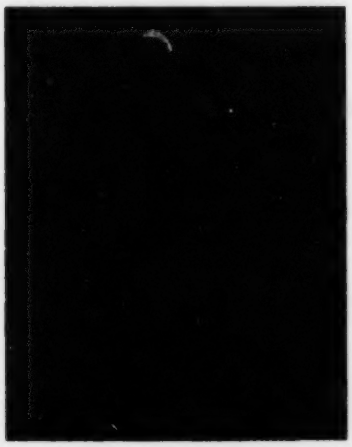


Fig. 35: Shepherd's crook

White Pine Weevil

Pissodes strobi (Peck)
(Coleoptera: Curculionidae)

The white pine weevil (Engelmann spruce weevil or Sitka spruce weevil) attacks native spruces and is particularly damaging to Sitka spruce regeneration on the coast. Terminal shoots of trees up to 15 m tall are attacked and killed or seriously injured, resulting in loss of growth and crooked or bushy trees. Weeviling is most severe in open-grown trees.

Adult weevils (**Fig. 33**) are 4 to 10 mm long and brownish, with irregular white and red-brown markings. They emerge from mid-April to July, when females puncture the terminal growth of the preceding year, laying eggs in some of these punctures. Not all punctures contain eggs; egg punctures are covered with a black substance (**Fig. 34**), whereas feeding punctures are not usually covered. Eggs are white, oval, and about 1 mm long; the incubation period is 10 to 14 days. Larvae mine from late May to August in the cambial tissues downward toward the base of the terminal, girdling and killing the

Fig. 36: Dead spruce terminal

terminal; the current year's growth elongates considerably before death. One of the first indications of weevil attack is the curled top or shepherd's crook (**Fig. 35**) which becomes apparent in late June and early July. Beginning in late July, 2-year-old needles turn red and drop (**Fig. 36**). It takes just over a month for each larva to develop fully and pupate. Fully developed larvae (**Fig. 37**) are yellowish white, legless grubs and slightly longer than the adults. Pupation takes place in August and lasts about 2 weeks. The cream-colored pupae are about the same length as the adults. Adults emerge from late August into December, most emerging in September and October. These adults overwinter in the duff or under moss or bark scales at the base of the tree boles and emerge the following spring.

Fig. 37: Fully developed white pine weevil larvae

Fig. 38: Bud midge larva in bud

Fig. 39: Spruce tip miner larva

Spruce Bud Miners

Spruce buds are attacked by three species of miners. They occur sporadically but can cause significant localized damage.

Spruce Bud Midge

Rhabdophaga sp. prob. *swainei* Felt
(Diptera: Cecidomyiidae)

The spruce bud midge attacks all spruces. It mines and destroys terminal buds (**Fig. 38**), causing multiple branching. Infested buds are larger than normal ones. Effects of this midge on cone production are not known.

The orange-pink eggs are oval, about 0.5 mm long, and laid when the spruce buds are bursting and shoots elongating in May or June. The incubation period is about 5 days. Larvae complete their feeding by fall, overwinter in buds, and pupate the following spring. Fully developed larvae are pale pink and 1.5 to 2.2 mm long. In April, prior to adult emergence, infested buds become rosette-like due to drying and recurving of the bud scales.

Fig. 40: Pupa and emergence hole (indicated by arrow)

Spruce Tip Miner

Argyresthia picea Freeman
(Lepidoptera: Yponomeutidae)

This insect attacks terminal buds of white spruce. Infested buds are somewhat larger than normal and are misshapen.

Larvae (**Fig. 39**) are pale cream with black heads and, when fully developed, are about 10 mm long. Larvae overwinter at the base of buds after making an emergence hole (**Fig. 40**). Pupation takes place in late March and April and adults emerge in May and June. The moths have narrow, yellowish, strongly fringed wings with a span of 6 to 14 mm.

Bud Moth

Zeiraphera spp.
(Lepidoptera: Olethreutidae)

Five species of bud moths attack spruces in British Columbia (the host relationships are listed in Furniss and Carolin [1977]). Young Sitka spruce trees have been stunted and deformed by *Z. pacifica* Freeman.

The life histories are not well known. Larvae are white to brown with brown heads (**Fig. 41**) and, when fully developed, are up to 14 mm long. Young caterpillars enter opening buds and feed on the new needles, webbing them together to form shelters under the bud caps. The damaged needles, which die and turn brown (**Fig. 42**) as twigs elongate, drop by midseason. Moths are mottled grey-brown, with wingspans of 10 to 20 mm.

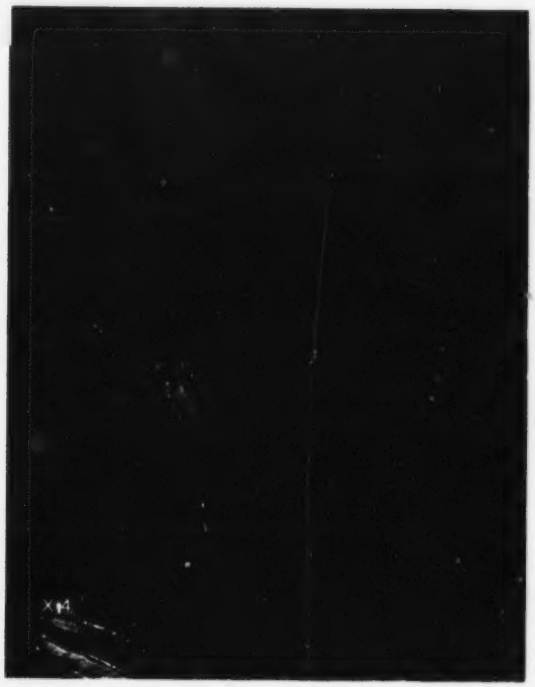


Fig. 41: Bud moth larva (on hemlock)

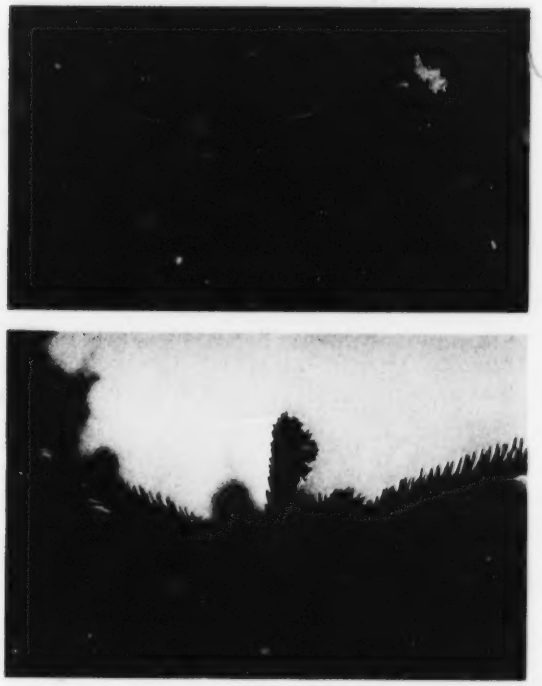


Fig. 42: Buds damaged by bud moths

Fig. 43: Egg masses of: (a) spruce budworm and (b) rusty tussock moth

Defoliators

Spruce is a host for several defoliators (**Figs. 43 and 44**), the most important of which feed on and damage other conifers more than spruce. These insects will occasionally attack spruce cones, but are not normally important seed pests. Cone crops in forests of eastern Canada have been completely destroyed during outbreaks of spruce budworm, *Choristoneura fumiferana* (Clemens), which feeds on cones in preference to foliage. This insect occurs only in northern interior areas of the province and devastating outbreaks, like those in eastern Canada, have not occurred. Defoliators pose a threat to seed orchard trees only when outbreaks occur in adjacent natural stands. Heavy defoliation can result in reduced cone production, top-kill, or mortality of branches or trees. More details about these defoliators are available in Furniss and Carolin (1977).

Several incidental defoliators also feed on spruce but usually do not cause significant damage.

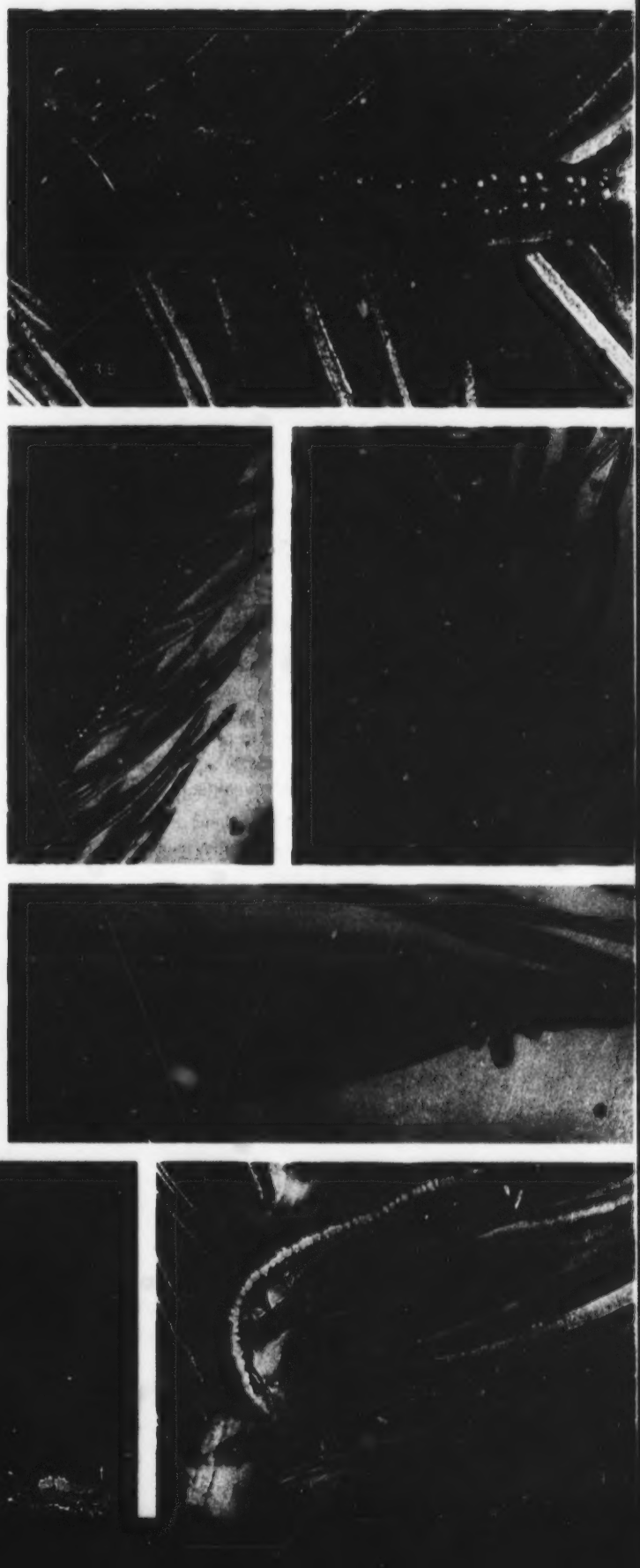


Fig. 44: **(a)** fully developed defoliator larva: spruce budworm (western and eastern spruce budworm larvae are similar in appearance)
(b) 2-year budworm
(c) black-headed budworm
(d) saddleback looper
(e) western hemlock looper
(f) rusty tussock moth
(g) spruce sawfly

Occasional Insects and Allied Pests

Many insects live on spruce trees but few are of economic significance. The following table lists insects that have caused significant damage to spruces on occasion and that may occur in seed orchards. These insects are discussed more fully in Furniss and Carolin (1977).

Insect	Host	Remarks
Spruce beetle *Dendroctonus rufipennis* (Kirby) (Coleoptera: Scolytidae)	All spruces	Normally attacks slash and windthrown trees but, during outbreaks, can kill standing trees; prefers trees greater than 50 cm d.b.h. diameter.
Bark beetles *Ips* spp. (Coleoptera: Scolytidae)	All spruces	Attack slash and tops of spruce beetle-killed white spruce trees.
Spruce needleminer *Taniva albolineana* (Kearfott) (Lepidoptera: Olethreutidae)	All spruces	Mines needles of ornamentals; orchards may be attractive to this insect.
Spruce spider mite *Oligonychus ununguis* (Jacobi) (Arachnida: Acariformes: Tetranychidae)	All spruces	Common pest of ornamentals and sometimes epidemic in forests; thrives under hot, dry conditions; may be a secondary pest (promoted by insecticide use).
Vine and root weevils *Otiorhynchus* spp. (Coleoptera: Curculionidae) **June beetles** *Polyphylla* spp. (Coleoptera: Lucanidae)	All spruces	Feed on roots of conifers (and other plants) and can kill seedlings; can be a problem during orchard establishment.
Spruce cone beetle *Ernobius nigrans* Fall (Coleoptera: Anobiidae)	Black spruce	Attacks dead cones; can be found in old cones on trees.

PREVENTION AND CONTROL

Cone and Seed Insects

Seed orchards present a different situation than do natural stands, with respect to management of seed pests. Orchard cones are picked every year so that overwintering cone insects are removed annually; consequently, every year the insects must reinvade the orchards from adjacent stands. Most cone and seed insects overwinter in cones; two notable exceptions are the spiral spruce-cone borer, which leaves the cones before they are harvested, and the western conifer seed bug, which feeds externally on cones. Losses to cone and seed insects can be reduced by:

- Establishing orchards in areas away from natural stands of the same species.
- Picking and removing from the orchard *all* cones every year to ensure removal of pests.

No insecticides are registered for use against spruce cone and seed insects; however, several systemic insecticides have been effective experimentally, and chemical control may shortly be possible[1]. For this reason, the following sections on sampling and timing of sprays are included.

The most damaging spruce cone and seed insects lay their eggs in the spring when pollination takes place. Young conelets should be examined for eggs immediately after pollination, using the following sampling methods:

- Sample 5% to 10% of the cone-bearing trees in the orchard. Select trees at random and pick 10 conelets from throughout the cone-bearing parts of each tree.
- Examine the conelets for spruce seedworm and spiral spruce-cone borer eggs. These eggs can be seen with the naked eye, but the use of a hand lens is recommended.
- Expect a seed loss of 10% to 20%, if 2 conelets from each tree have one or more eggs of either insect. Spraying should be carried out if infestations reach or exceed this level.

Before using insecticides, ensure all recommended procedures and precautions are strictly adhered to. Read the pesticide label and follow the procedures listed.

The optimum time for application of systemic insecticides is when young conelets have closed and are starting to turn down. If sprays are applied when conelets have reached the pendant position, some damage will have already occurred, especially by the spiral spruce-cone borer. It will be difficult to spray all the trees at the optimum stage of development, unless spraying is carried out on a tree-by-tree basis, because of variations in cone development among trees. If spraying is carried out on a single-shot orchard basis, the majority of the conelets should be between the closed and turning and horizontal stages of development.

Aphids

Cooley Spruce-Gall Aphid

A major method of reducing damage by the Cooley spruce-gall aphid is to avoid planting spruce adjacent to Douglas-fir. The aphid can be prevented from forming galls by spraying a currently recommended insecticide[1] about the time of vegetative bud flush (May or June, depending on location). An insecticidal soap[1] can also be used; however, if young conelets are present at the time of spraying, caution should be exercised, as the soap may cause conelet abortion.

Spruce Aphid

The green spruce aphid can be controlled with insecticidal soap[1], applied until the trees are soaked (preferably with a hydraulic sprayer). It is important to spray the underside of needles because this is where the aphids are located. The soap solution is low in toxicity to nontarget organisms. Applications should be made when populations warrant control (usually in the spring, if at all). However, note the problem of phytotoxicity of oleate soap to conelets in the section on Cooley spruce-gall aphid. A currently recommended insecticide[1] could also be used.

[1] For recommendations, see the most recent edition of the Nursery Production Guide, B.C. Ministry of Agriculture.

DISEASES

Inland Spruce Cone Rust

Chrysomyxa pirolata Wint.
(Uredinales: Melampsoraceae)

and

Coastal Spruce Cone Rust

C. monesis Ziller
(Uredinales: Melampsoraceae)

Inland spruce cone rust affects *Picea* spp. cones across the North Temperate Zone; in 1979, it affected about 30% of the white spruce cones at Skimikin Seed Orchard near Salmon Arm. Depending upon such factors as host, weather, and locality, yellow-orange rust spores (aeciospores) appear around the edges of cone scales from mid-June to mid-July. At this stage, the disease can be overlooked, unless the cones are opened to reveal the masses of spores (**Fig. 45**). Later, these yellow spores become more noticeable as the cones dry out, causing the scales to open, beginning at the proximal end (**Fig. 46**). Seeds usually fail to develop in affected cones and, those that do, may germinate abnormally. Diseased cones may harbor the fir coneworm, *Dioryctria abietivorella* (Groté).

Spores from cones do not spread the disease to other cones, but only to the alternate hosts—wintergreens, *Pyrola* spp., and single-delight, *Moneses uniflora* (L.) A. Gray. The rust is systemic and perennial in these alternate hosts; in late spring or early summer, two kinds of yellow-orange spore-producing pustules (**Fig. 47**) appear on the underside of their leaves. Spores (urediospores) from one kind of pustule, which persist throughout the growing season, spread the disease to other wintergreens and single-delight, while other pustules produce spores (basidiospores) that are inoculum for spruce cones. Apparently, cones are susceptible shortly before, during, and after pollination. Possible controls include either alternate host eradication around the seed orchard or application of fungicides to cones, or both.

Coastal spruce cone rust, affecting Sitka spruce cones in the Queen Charlotte Islands, could become important if seed orchards of that species are established there. Its life history, symptoms, and control are similar to *C. pirolata*.

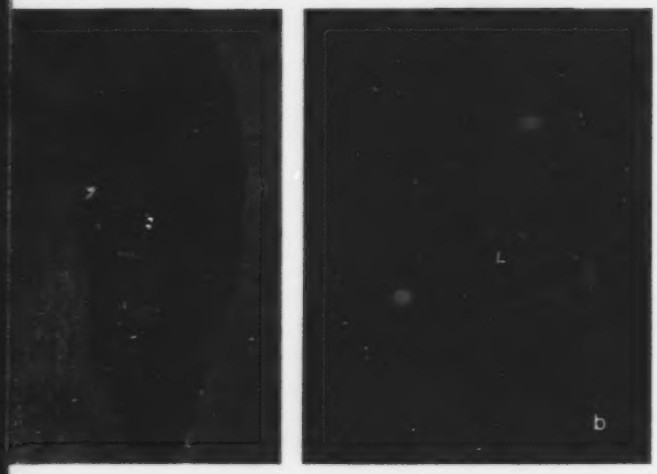


Fig. 45: Diseased spruce cone, **(a)** intact and **(b)** broken, to reveal yellow-orange rust spores; early in midsummer

Fig. 46: Yellow-orange rust spores and opening of diseased spruce cone; mid- to late summer

Fig. 47: Yellow-orange spore-producing pustules on underside of an alternate host (*Pyrola*) leaf

GLOSSARY OF TERMS

aeciospore . . . . . one of several kinds of spores produced by a rust fungus. Formed in and released from a fruiting structure called aecium[1].

basidiospore . . . . . the spore produced by the sexual stage of the basidiomycetes[1].

cocoon . . . . . a silky case spun by the larva of an insect to live in while it is a pupa.

diapause . . . . . a condition of suspended animation or arrested development during the life cycle of an insect[2].

frass . . . . . the solid excrement of an insect, particularly of a larva[2].

fungicide . . . . . chemical that is toxic to fungi[1].

gall . . . . . a pronounced swelling on a woody plant caused by certain fungi, bacteria, insects, or nematodes[1].

hibernaculum(a) . . . a silk sheath or tent in which a larva overwinters[2].

larva(e) . . . . . a young insect differing fundamentally in form from the adult, typical of insects that undergo complete metamorphosis, as in Coleoptera, Hymenoptera, and Diptera[1].

nymph . . . . . the immature feeding stage of insects that develop to the adult without a pupal stage; nymphs are usually similar in form to the adult[2].

pupa(e) . . . . . resting stage of insects having completed metamorphosis[2].

spore . . . . . the reproductive structure of the fungi and other lower plants[1].

systemic . . . . . affecting, or distributed throughout, the whole plant body[1].

urediospore . . . . . one of the many spore stages produced by the rust fungi in their complicated life cycle; these spores are produced in a fruiting body called a uredinium[1].

[1] Source: Sutherland and Van Eerden (1980)

[2] Source: Hedlin et al. (1980)

REFERENCES

Foster, R.E. and G.W. Wallis. 1969. Common tree diseases in British Columbia. Can. Dep. Fish. For., For. Br., Publ. No. 1245, 116 pp.

Furniss, R.L. and V.M. Carolin. 1977. Western forest insects. USDA For. Serv., Washington, D.C., Misc. Publ. No. 1339, 654 pp.

Hedlin, A.F. 1973. Spruce cone insects in British Columbia and their control. Can. Ent. 105:113-122.

Hedlin, A.F. 1974. Cone and seed insects. Environ. Can., Can. For. Serv., Pacific For. Res. Centre, Victoria, B.C., Info. Rep. BC-X-90, 63 pp.

Hedlin, A.F., H.O. Yates, D.C. Tovar, B.H. Ebel, T.W. Koerber, and E.P. Merkel. 1980. Cone and seed insects of North American conifers. Environ. Can., Can. For. Serv./USDA For. Serv./ Sec. Agric. Recur. Hidraul., Mexico, Victoria, B.C., 122 pp.

Sutherland, J.R. and E. Van Eerden. 1980. Diseases and insect pests in British Columbia forest nurseries. B.C. Min. For./Can. For. Serv., Joint Rep. No. 12, 55 pp.

Ziller, W.G. 1974. The tree rusts of western Canada. Dep. Environ., Can. For. Serv., Ottawa, Publ. No. 1329, 272 pp.

Environment Canada
Canadian Forestry Service
Pacific Forest Research Centre
506 West Burnside Road
Victoria, B.C. V8Z 1M5

BC-X-231

1982

Canada